8824 – 6904M

Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

November 2024

Computer science

Higher level

Paper 1

18 pages

Subject details: **Computer science HL paper 1 markscheme**

Mark allocation

Section A: Candidates are required to answer **all** questions. Total 25 marks.
Section B: Candidates are required to answer **all** questions. Total 75 marks.
Maximum total = 100 marks.

General

A markscheme often has more specific points worthy of a mark than the total allows. This is intentional. Do not award more than the maximum marks allowed for that part of a question.

When deciding upon alternative answers by candidates to those given in the markscheme, consider the following points:

Each statement worth one point has a separate line and the end is signified by means of a semi-colon (;).

An alternative answer or wording is indicated in the markscheme by a "/"; either wording can be accepted.

Words in (…) in the markscheme are not necessary to gain the mark.

If the candidate's answer has the same meaning or can be clearly interpreted as being the same as that in the markscheme then award the mark.

Mark positively. Give candidates credit for what they have achieved and for what they have got correct, rather than penalizing them for what they have not achieved or what they have got wrong.

Remember that many candidates are writing in a second language; be forgiving of minor linguistic slips. In this subject effective communication is more important than grammatical accuracy.

Occasionally, a part of a question may require a calculation whose answer is required for subsequent parts. If an error is made in the first part then it should be penalized. However, if the incorrect answer is used correctly in subsequent parts then **follow through** marks should be awarded. Indicate this with "**FT**".

General guidance

Issue	Guidance
Answering more than the quantity of responses prescribed in the questions	In the case of an "identify" question, read all answers and mark positively up to the maximum marks. Disregard incorrect answers. In the case of a "describe" question, which asks for a certain number of facts *eg* "describe two kinds", mark the first two correct answers. This could include two descriptions, one description and one identification, or two identifications. In the case of an "explain" question, which asks for a specified number of explanations *eg* "explain two reasons …", mark the first two correct answers. This could include two full explanations, one explanation, one partial explanation *etc*.

Section A

1. *Award **[2 max]***

Neatly organized information (rows and columns, tables, dropdown lists, worksheets)
Automatic calculation based on the formulas/functions (custom or pre-set);
Data filtering;
Data visualization (bar charts/pie charts/graphs/ variety of styles and colours);
Cell/table formatting (custom or pre-set) (sizes, colours, cell background, insert headers, merge cells, etc.);
Conditional formatting;
Automated tasks (auto-fill cells, update cell values, automated formatting);
Text manipulation;
Sorting;
Pivot tables;
Data validation;
Comments/ notes (for collaboration and clarification);
Sharing and co-authoring (multiple users can work on one document simultaneously);
Data import/ export (easily import data from various sources (e.g., databases), save spreadsheets in different formats (e.g., PDF);
Security features (password protection, file encryption);
Accessibility features (screen reader, assistive technologies for visually impaired users, keyboard shortcuts);
***Note**: Reward other correct responses.*

2. *Award **[2 max]***

helps to reduce the risk of program/ product failure;
by getting direct feedback from real / end users (each end user performs testing in the end-user's location);

beta testing allows the testing of the product over a range of devices/networks/ operating systems;
allowing the developers to test functionality over a range of environments and configurations*;*

show how the program works in real-world environment / test by real users;
help to detect any issues/bugs (which are overlooked/undetected by the development team /during internal testing);

beta testing engages end users (and creates excitement);
which helps building a loyal user/customer base;

***Note**: Reward other reasonable responses.*

3. *Award **[2 max]***
the users identify key issues (positive and negative) in the current computer system;
describe what they think is wrong with the current computer system;
explain how they use the current system;
explain how they think the current system can be improved;
the users can test and provide feedback on the new system;

***Note**: Reward other correct responses.*

4. *Award **[2 max]***

to graphically/diagrammatically present a system;
describing the devices/files/media used and tasks/events to be performed by the system;
so, to help better understand the system/ identify bottlenecks/ inefficiencies/ redundancies/ suggest improvements/ optimizations;

to represent all the components in a system (inputs and outputs, storage, processes, and decisions);
using standard symbols (shapes, arrows);
that provide visual clarity/ help to understand/ analyse the flow of the process;

5. *Award **[3 max]***

A firewall (a device or software protecting sensitive resources in a network)
controls incoming and outgoing network traffic according to predetermined security rules;
monitors data packets entering and leaving the guarded network, allowing or blocking them;
controls which applications/devices can access the network;
detects/ prevents other threats, such as viruses, malware, suspicious behaviour, different types of Internet attacks;

6. *Award **[2 max]***
Modularity;
Extensibility;
Reusability;
Improved testing/ debugging;
Maintainability;
Abstraction;
***Note:** A single word does not have to be used, accept descriptions.*

7. *Award **[4 max]***
The work out may be differently presented.

```
rec(20,12) = rec (12, 20 mod 12) = rec (12, 8) ;
           = rec (8, 12 mod 8) = rec (8, 4)    ;
           = rec (4, 8 mod 4) = rec (4, 0)     ;
           = 4                                 ;
```

8. *Award **[2 max]***
Award [1] for identifying the advantage and award [1] for stating why robots provide this advantage.

Improved quality of cars;
robots are more precise/ reliable than humans;

Increased safety;
Using robots for boring/ repetitive tasks means fewer risks of injury for workers/ robots can work in hazardous conditions (painting, assembling parts);

Reduced costs;
No salaries required/ healthcare savings/ insurance savings;

Increased speed for manufacturing processes;
robots work at constant speed/ don't need breaks / robots operate 24/ ;

***Note**: Reward other reasonable answers.*

9. (a) *Award **[1 max]***

X E H Y C A;

(b) *Award **[1 max]***

X A E C H Y;

10. *Award **[4 max]***
*Award **[1]** for naming a queue operation and award **[1]** for defining/describing the operation**, x2**.*

Enqueue;
adds (stores) an item to(at) the back of the queue;

Dequeue;
removes (and returns) an item from the front of the queue;

isEmpty;
is used to check if the queue contains any elements or not/ returns True if the queue is empty, False if the queue is not empty;

isFull;
is used to check if the queue has reached its maximum capacity/ returns True if the queue is full, returns False if it is not full;

front/peek;
returns the value of the first item without deleting it;

Section B

11. (a) *Award **[1 max]***

A password should be assigned to the device (biometric passwords could be used);
Should not store sensitive data on the laptop;
Safeguard all passwords / should not store username/password account logins (or "remember me" cookies) on the device;
Encrypt the SSD / hard drive;

***Note:** Reward other correct responses.*

***Note:** Backing-up will not keep the data secure, it will only allow recovery of data removed, so no marks for the answer: 'Regularly back up the SSD / hard drive to another location'.*

(b) *Award **[2 max]***
*Award **[1]** for identifying an OS feature and award **[1]** for a reasonable expansion.*

Security management;
confidential data stored in the system is protected by the operating system/ the system is protected from malware attack;

GUI / I/O operations;
OS can handle I/O operations to hide the behaviour of hardware from the user;

Process management;
The program execution is managed effectively by the operating system without any overlapping or time delay/ The OS to develop and provides mechanism for communication and synchronization within multiple processes;

Storage/ Memory management;
OS performs memory management and virtual memory multitasking/ The need for memory management in OS is to allocate and de-allocate memory space to process/ The OS can do resource allocation and prevent the system from overloading /to ensure it meets the minimum requirements of the application;

Disk management;
OS permits disk access to manage files systems, file system device drivers and related activities of files like retrieval, naming, sharing, storage, protection of files;

Loading and execution;
The command interpretation is made to interpret the given commands and make the resources to act on the system by processing the commands;

***Note**: Reward other correct answers.*

(c) *Award **[4 max]***

(*the laptop manufacturer includes both wired and wireless network connection capability*) to deliver customer (laptop user/owner) satisfaction/ customer loyalty/ improve overall customer experience/ meet customer expectations;
laptop users (customers) can decide which connection is best (for them) in a particular situation;
users can move around freely / able to work in a setting outside the home/ office (and still stay connected from any location within the wireless network's coverage area or from any WIFI hotspot);
for tasks that require large amounts of data to be transferred users are able to use a wired network rather than wireless as the bandwidth is much larger/ faster transmission;
where wireless connection is weak/ unavailable users can count on an Ethernet cable adapter/ use wired network to get the connection they need;
wireless networks can be easily hacked, so wired connection can be used when working / transferring sensitive data/ it is more difficult for unauthorised users to intercept data in a wired network;

***Note**: Reward other reasonable benefits to their customers (laptop users) (knowing the advantages/ disadvantages of wired/ wireless connections) such as convenience, increased mobility, security, cost.*

(d) *Award **[2 max]***

The data packet structure includes the header, payload (and trailer);
It contains information about the data carried by the data packet such as its origin and destination IP addresses, number of packets, etc.;
the actual data (payload) that the packet is delivering to the destination;
and control signals/ additional information about the packet (such as data that tell the receiving device that it has reached the end of the packet);

(e) *Award **[6 max]***
*Award **[1]** for a reason, award **[1]** for an extension, **x3**.*

(Network protocols are necessary because protocols do)

provide the rules for effectively managing/ operating a computer network;
allowing network administrators to monitor network performance/ detect bottlenecks /identify and troubleshoot network issues/ configure network devices remotely / for example, network management protocols such as ICMP and SNMP;

define the policies/ procedures to determine how data is transmitted between different devices in the network;
for example, network communication protocols such as TCP/IP and HTTP;

provide security services (for example, encryption, authentication) for data transmitted over the network;
for example, network security protocols such as IPSec, HTTPS, SFTP, and SSL;

include mechanisms/functions for flow control;
mechanisms for devices to identify and make connections/ formatting rules that specify how data is packaged into messages sent and received / the amount of transferred data between the communicating computers must be agreed in such a way that the data can always be stored on the target computer;

include error checking functions (in a communication protocol);
that help to detect errors/ eliminate distortions (for example, distortions that can be caused by the poor quality of the transmission, etc.);

include mechanisms for congestion control /include precautions that serve not to overload a network;
because when overloading a network, the transmitted data blocks often have to be discarded/ the transmission time of data blocks in the network by ‘congestion’ in nodes increases;

include mechanisms for deadlock control/ mechanisms to prevent/detect/avoid deadlock;
a situation that occurs when a process of transmission is in a wait state and some packets cannot advance toward their destination because are waiting on one another to release resources;

ensure integrity /accuracy/ completeness/ consistency/ validity of data;
by organizing data in a way that ensures the secure transmission between the origin/sender and destination/receiver;

12. (a) (i) *Award **[1 max]***

OR, AND;

(ii) *Award **[1 max]***

6, 3, 20;

(iii) *Award **[2 max]***
*Award **[1]** for the correct result (True) and award **[1]** for working.*

(6 > 6) OR (6 > 3) AND (6 + 6 < 20)
False OR True AND True
False OR True
True

(b) *Award **[4 max]***
*Award **[1]** for every two correct rows.*

MOTION	DOOR	WINDOW	SIREN
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

(c) (i) *Award **[1 max]***

Memory Data Register/ MDR;

(ii) *Award **[1 max]***

Control Unit/ CU;

(iii) *Award **[1 max]***

Arithmetic and Logic Unit/ ALU;

(iv) *Award **[4 max]***

Buses connect hardware components/ transfer information/signals between different components (CU, ALU, RAM, registers);
Address bus carries the address of the memory location from where data should be read/ written:
Data bus carries the actual data which need to be stored on/ written to the primary memory;
Control bus carries control/ timing signals from CU to other components;
Buses carry power supply to all components;

13. (a) *Award **[2 max]***

all parameters from the application will be pushed onto a stack;
and popped off back (into the CPU) when the call is over;

when the incoming call arrives, the OS saves the current state of the app and pushes it onto the stack;
once the call is ended the OS pops the most recent state (the state of the app right before the call) from the stack and restores it;

(b) *Award **[2 max]***
*Award **[1]** for identifying a way and award **[1]** for an expansion.*

Different health cell phone apps can track/record data;
To detect unhealthy conditions;

***Note:** Accept examples of cell phone apps that can monitor any vital signs and be used in diagnostic, such as sleep tracking functionality in prenatal care, etc.*

Cell phone apps can access nutrition information/guide;
So, users can eat healthier food;

Cell phone apps to monitor/track exercise (track distance, time, speed, and calories burned);
And serve a role as motivator to do more of it;

***Note**: Accept other reasonable answers.*

(c) *Award **[2 max]***

by increasing screen resolution more elements can be addressed on the same area of screen;
so, more data from an image can be displayed (in the same area);

higher screen resolution means finer colour transition/ better colour gradients;
especially in areas where colours shift gradually;

higher screen resolution increases text clarity;
so even smaller font sizes can be read as the letters appear better defined;

higher resolutions indicate more pixels;
so, more details can be captured;

(d) (i)*Award **[4 max]***

The Global Positioning System (GPS) is a navigation system/ a system used to determine the ground position of an object;
It consists of three segments: satellites, control (made up of Earth-based monitor stations), and GPS receivers (user equipment);
A number of satellites continuously send out signals containing their position and the exact time the signal was sent;
GPS receiver (*accept mobile phones*) picks up the signal and determines the distance to each satellite (by calculating the time required to receive the signal);
By using trilateration, it determines the exact location (by knowing the distance to at least four satellites);

(ii) *Award **[2 max]***
*Award **[1]** for a concern and **[1]** for an expansion.*

Privacy concerns;
All the time and at all locations/ in a place and time when a user has a reasonable expectation of privacy;

Safety concerns;
surveillance is possible/ possible sharing the user's whereabouts with stalkers;

Advertisers could profile;
User's physical/online habits;

Erroneous data could be created;
Because of missing/incorrect location information;

(e) *Award **[3 max]***

A dedicated operating system for a mobile phone will take up less storage space than a full-sized operating system;
this will allow the device to function more quickly;
because it doesn't contain features that aren't needed;

The operating system is optimized for speed/ made to be as fast as possible;
uses resources effectively;
because it is created for a specific hardware;

Security is improved;
by prohibiting services that would run on a generic operating system/ prohibiting software update;
only allowing very specific range of IP addresses or keys allowed;

To suit a particular individual or task / customization;
only a minimal/ basic modification can be made;
in user interface/ the network connections/ and virtually anything else;

A dedicated OS is designed specifically for a task;
makes the most efficient use of hardware available;
does not include unnecessary features;

Note: *Accept other reasonable answers on customization/ security/ speed/ optimization.*

14. (a) *Award **[4 max]***
*Award **[1]** for an advantage and **[1]** mark for an expansion, **x2**.*

Names can be inserted/deleted quickly/easy just by manipulating the pointers/ by updating the address;
without resorting/shuffling (as in an array);

Better use of memory/ the number of names (size of the list) is not fixed (as in an array);
so, no wasted space / linked list can shrink and grow at the runtime (by deallocating or allocating memory);

No need for an initial size/ predetermined size in linked list (as in an array);
which allocate space that may or may not be fully in use;

(b) *Award **[5 max]***
Temporary pointer should be used;
and initially set to point to the beginning of the list;
loop through the list;
follow the internal pointers;
compare the name in the node pointed to by the temporary pointer with the searched name;
If they are same (the name is found) then stop searching;
If the end of the list is reached / temporary pointer equals null then the searched name is not on the list;

(c) (i) *Award **[4 max]***
Double linked list DLL has two external pointers, one pointer points to the first element of the DLL, and other points to the last element in the DLL;
Each node consists of a data field(s);
and two pointers (for example, called NEXT and PREV);
Each node is linked with its next node (using its pointer NEXT) and previous node (using its pointer PREV);
The NEXT pointer of the last node is null (to mark the end of the list - forward traversal) and the PREV pointer of the first node is null (to mark the end of list - backward traversal);
***Note**: Accept diagrams.*

(ii) *Award **[2 max]***
Storing the browsing history which allow going forward and backwards in browsing history;
A music player which has next and previous buttons;
In LRU caching/ cache that is employed in cases which uses most/least recently accessed items/ examples like in the case of android phone home screen to save the most recently used apps;
An application that has a ‘Most Recently Used’ element / for example, list of file names;
In games, to represent anything that requires an order in a game / A DLL can be used to represent a deck of cards;
Undo-Redo functionality (for example, in word processing);

***Note**: Accept any application where front and back navigation is required.*

15. (a) *Award **[4 max]***

Example 1:
*Award **[1]** for the row loop*
*Award **[1]** for the column loop*
*Award **[1]** for the correct index (index in the COUNT array is MAT[R][C])*
*Award **[1]** for incrementing the correct element in the COUNT array*

```
loop R from 0 to 6  //accept 6 or MAT.length-1
     loop C from 0 to 6
          COUNT[MAT[R][C]] = COUNT[MAT[R][C]] + 1
     end loop
end loop
```

Example 2:
*Award **[4 max]** as follows:*
*Award **[1]** for the outer loop*
*Award **[1]** for the inner loop*
*Award **[2]** for correct if statement (comparing MAT[R][C] with all values in the range from 0 to 9), award **[1]** for a minor error*
*Award **[1]** for incrementing the correct element in the COUNT array*

```
loop R from 0 to 6
  loop C from 0 to 6
     if MAT[R][C]] = 0 then COUNT[0] = COUNT[0]+1
       else if MAT[R][C]] = 1 then COUNT[1] = COUNT[1]+1
        else if MAT[R][C]] = 2 then COUNT[2]= COUNT[2]+1
          else if MAT[R][C]] = 3 then COUNT[3]= COUNT[3]+1
            else if MAT[R][C]] = 4 then COUNT[4]= COUNT[4]+1
             else if MAT[R][C]] = 5 then COUNT[5]= COUNT[5]+1
              else if MAT[R][C]] = 6 then COUNT[6]=C OUNT[6]+1
               else if MAT[R][C]] = 7 then COUNT[7]= COUNT[7]+1
                else if MAT[R][C]] = 8 then COUNT[8]= COUNT[8]+1
                 else if MAT[R][C]] = 9 then COUNT[9]= COUNT[9]+1
                       end if
                      end if
                    end if
                   end if
                  end if
                end if
              end if
            end if
          end if
        end if
      end if
     end if
   end loop
end loop
```

(b) *Award **[5 max]***
*Award **[1]** for using a flag*
*Award **[1]** for a correct loop (for, while, loop until)*
*Award **[1]** for the correct condition in if statement and changing the flag (if needed)*
*Award **[1]** for outputting all numbers that do not appear in MAT*
*Award **[1]** for checking the flag (if statement) after the loop*
*Award **[1]** for outputting an appropriate message*

```
F=0
loop K from 0 to 9 //accept 9 or COUNT.length-1
    if COUNT[K]=0
        then
              F = 1
              output(K)
    end if
end loop
if F = 0
    then output ('all the numbers from 0 to 9 are present ')
end if
```

(c) *Award **[6 max]***

Example 1:

*Award **[1]** for initializing HV*
*Award **[1]** for a correct loop*
*Award **[1]** for comparing COUNT[K] with HV*
*Award **[1]** for changing the value of HV (if needed)*
*Award **[1]** for the second loop (loop after the first one)*
*Award **[1]** for checking if HV is equal to COUNT[K]*
*Award **[1]** for outputting values that occur most frequently*

```
//searches for the highest value in the COUNT array
HV=0    // or HV = COUNT[0]
loop K from 0 to 9
    if COUNT[K] > HV
           then HV = COUNT[K]
      end if
end loop

//outputs the mode(s)
loop K from 0 to 9
    if COUNT[K] = HV
        then output(K)
    end if
end loop
```

Example 2:

*Award **[1]** for initializing MAX*
*Award **[1]** for a correct loop*
*Award **[1]** for comparing COUNT[K] with MAX and changing the value of MODE_IND[K] (if they are equal)*
*Award **[1]** for comparing COUNT[K] with MAX and changing the value of MAX (if COUNT[K] is greater than MAX)*
*Award **[1]** for reinitializing the MODE_IND array (the loop within if statement)*
*Award **[1]** for assignment MODE_IND[K]=1*
*Award **[1]** for outputting modes*

```
//assume MODE_IND is initialized
//an integer array zero array in this example, a Boolean array could be
//used instead
//the MODE_IND array is used to flag modes

MAX = 0   // MAX = COUNT[0]
loop K from 0 to 9
      if COUNT[K] == MAX
          then MODE_IND[K] = 1   //flags mode K
      endif
      if COUNT[K] > MAX
         then
              MAX = COUNT[K] //the new largest value
              loop I from 0 to 9
                    MODE_IND[I] = 0  //reinitializing the array
              end loop
              MODE_IND[K] = 1 //flags the new mode K
      end if
end loop

loop K from 0 to 9        // outputs modes
     if MODE_IND[K] == 1
          then output(K)
               end if
end loop
```